How Patches Grow Up and Go to School

Khouloud Touil & Kevin Hilman
, BayLibre

Introductions

BayLibre

- embedded Linux consultancy
- based in Nice, France
- ~40 engineers
- open-source focus
  - top 20 Linux kernel contributor
  - top 5 AGL contributor
  - u-boot, Zephyr, ATF, OP-TEE, Yocto
  - automated testing, SOTA

Khouloud

- SW engineer
- based in Nice, France
- KernelCI contributor

Kevin

- co-founder, Sr. Engineer
- Linux kernel developer, maintainer
- based in Seattle
- co-founder KernelCI project

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KernelCI

Um, so what is... KernelCI

A free **service** for testing Linux on a huge variety of hardware platforms
https://kernelci.org

An open source **project**
the software behind the service

A **collaboration hub** for hardware-focused, open source testing and automation

THE LINUX FOUNDATION

Mission Statement

To ensure the quality, stability and long-term maintenance of the Linux kernel by maintaining an open ecosystem around test automation practices and principles.

https://foundation.kernelci.org/mission-objectives/

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Founding Members

How a patch grows & goes to school

Newborn
- Just an idea

Toddler years
- review on **mailing list**
- falls down a lot

Primary school
- lands in **maintainer tree**
- learns to play well with others
- maybe gets teased a bit

High school
- **linux-next**
- fight with friends

University
- **mainline**
- make new friends

Graduation
- Long-term stable (**LTS**)
- get a commercial job

Caveat: not all students follow this path. It's entirely possible to get a job without going to university. c.f. `PREEMPT_RT`

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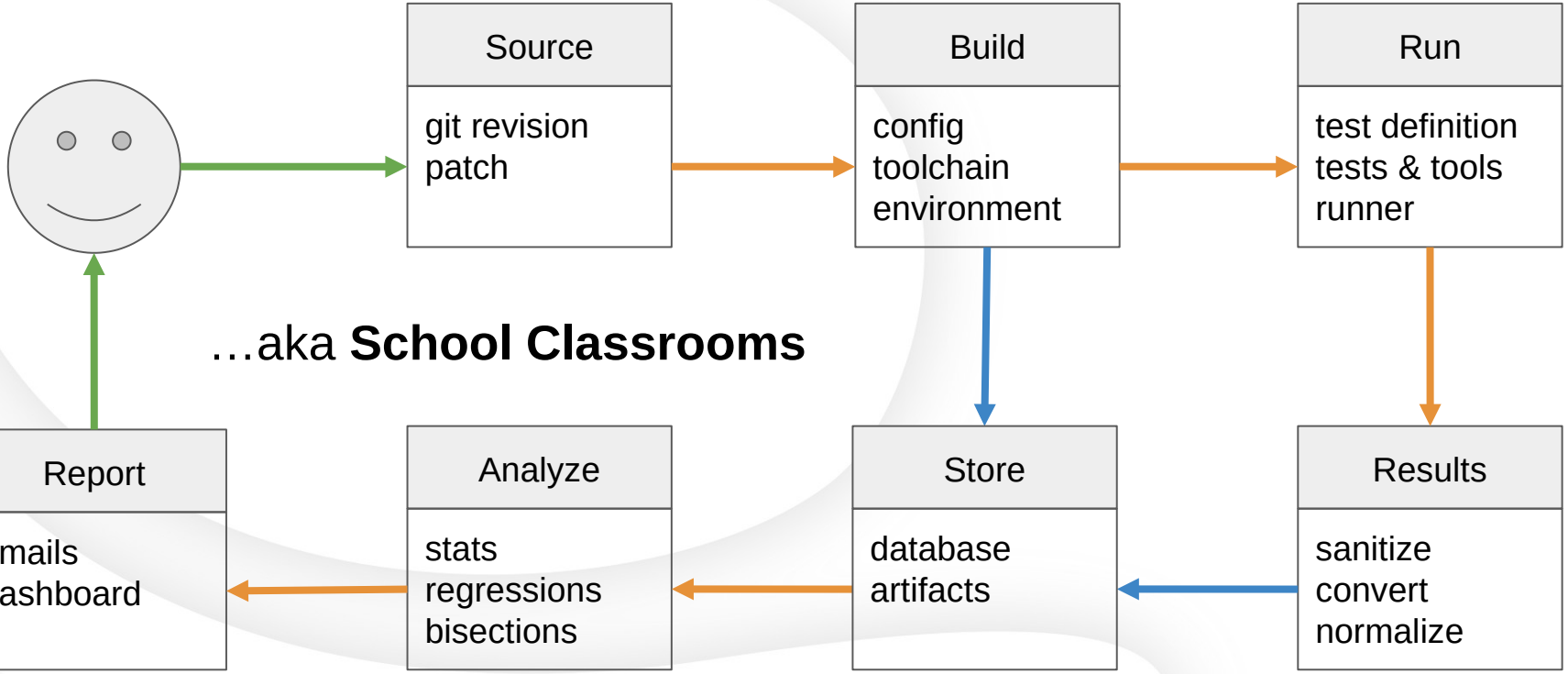
KernelCI

KernelCI Modular Pipeline



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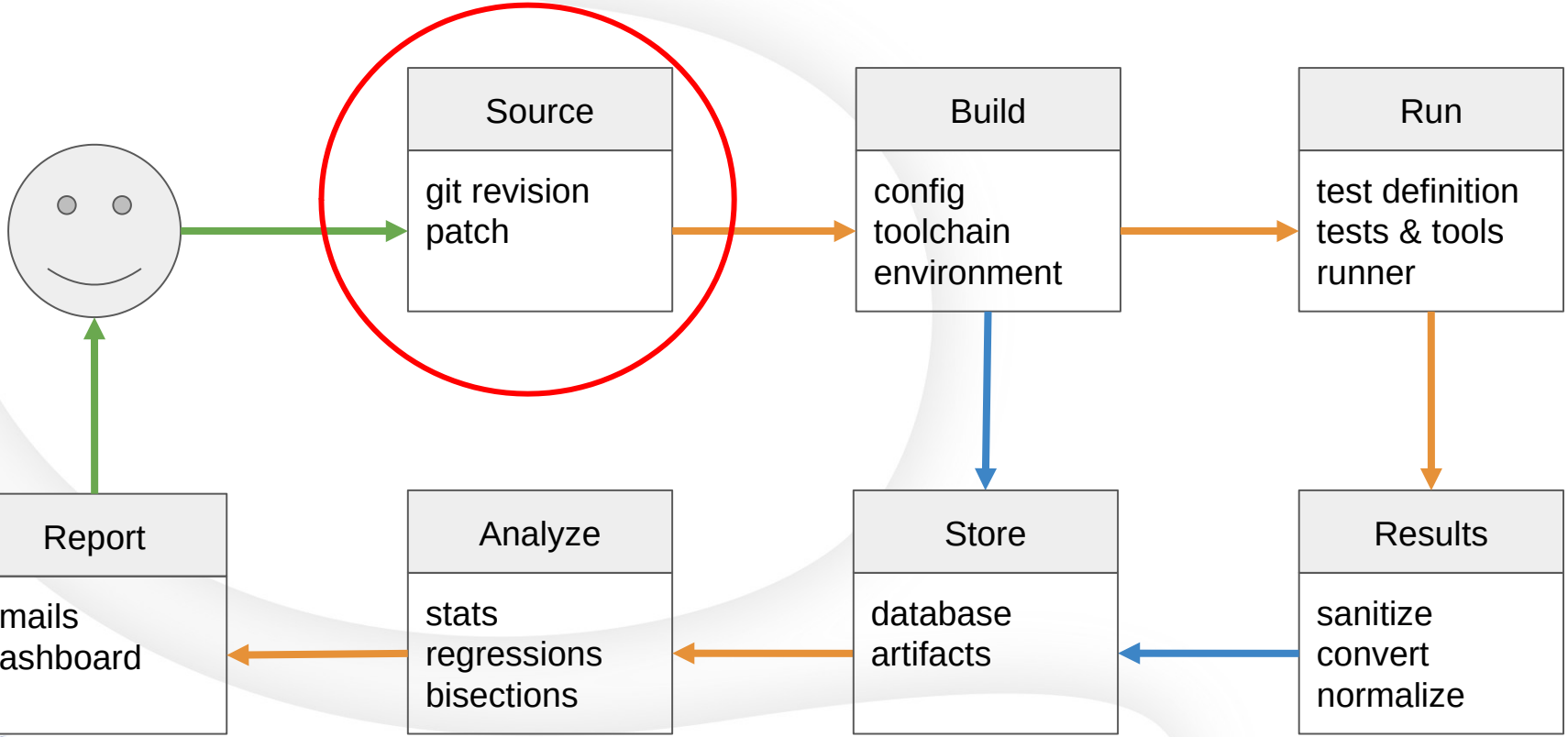
Source
git revision
patch
Build
config
toolchain
environment
Run
test definition
tests & tools
runner
Report
emails
dashboard
Analyze
stats
regressions
bisections
Store
database
artifacts
Results
sanitize
convert
normalize

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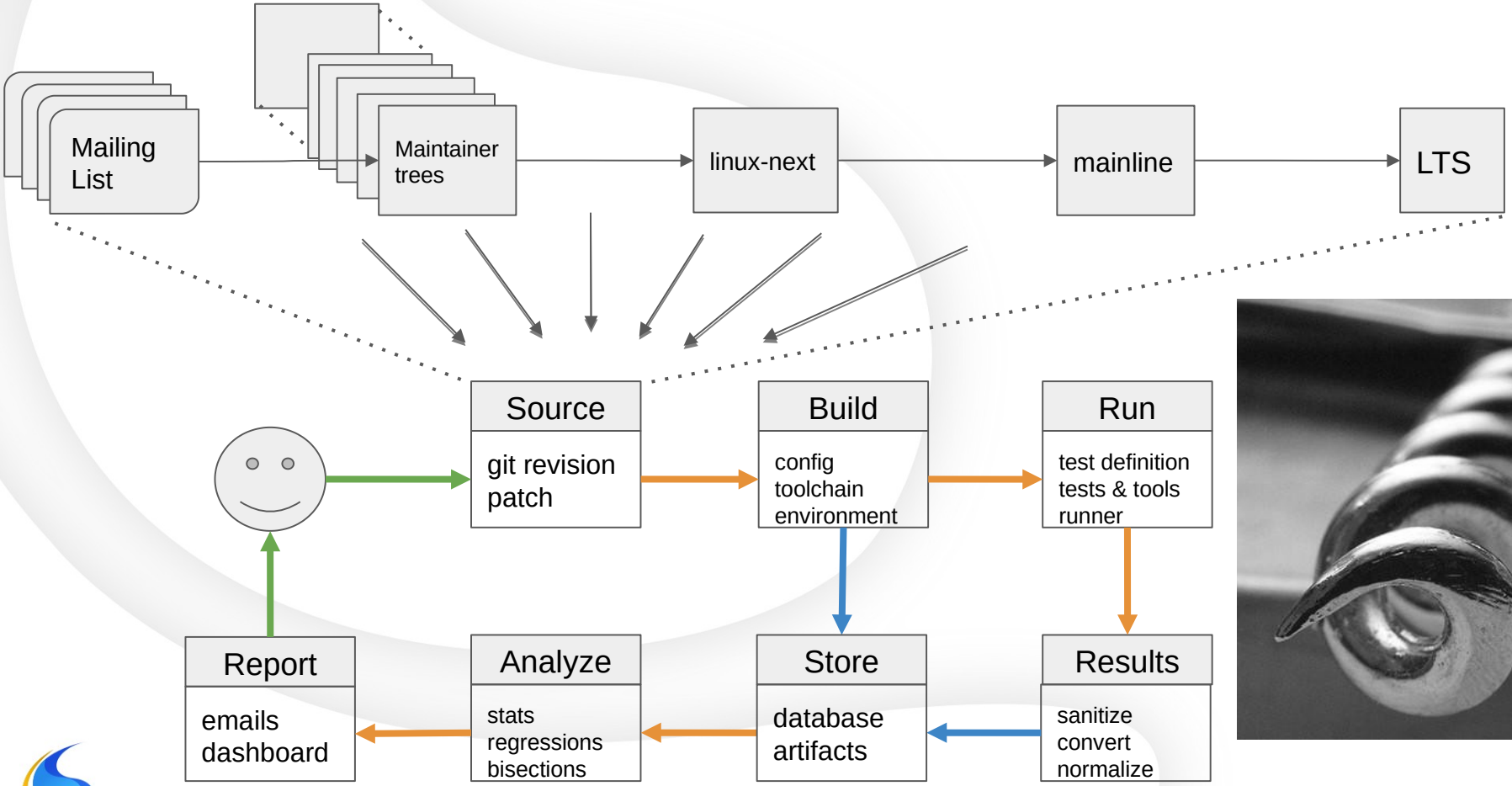
Mailing List
Maintainer trees
linux-next
mainline
LTS
Source
git revision
patch
Build
config
toolchain
environment
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test definition
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Source - Next

Test patches and series directly from mailing-list

Integration with new maintainer tooling (e.g. b4)

More compute = more builds

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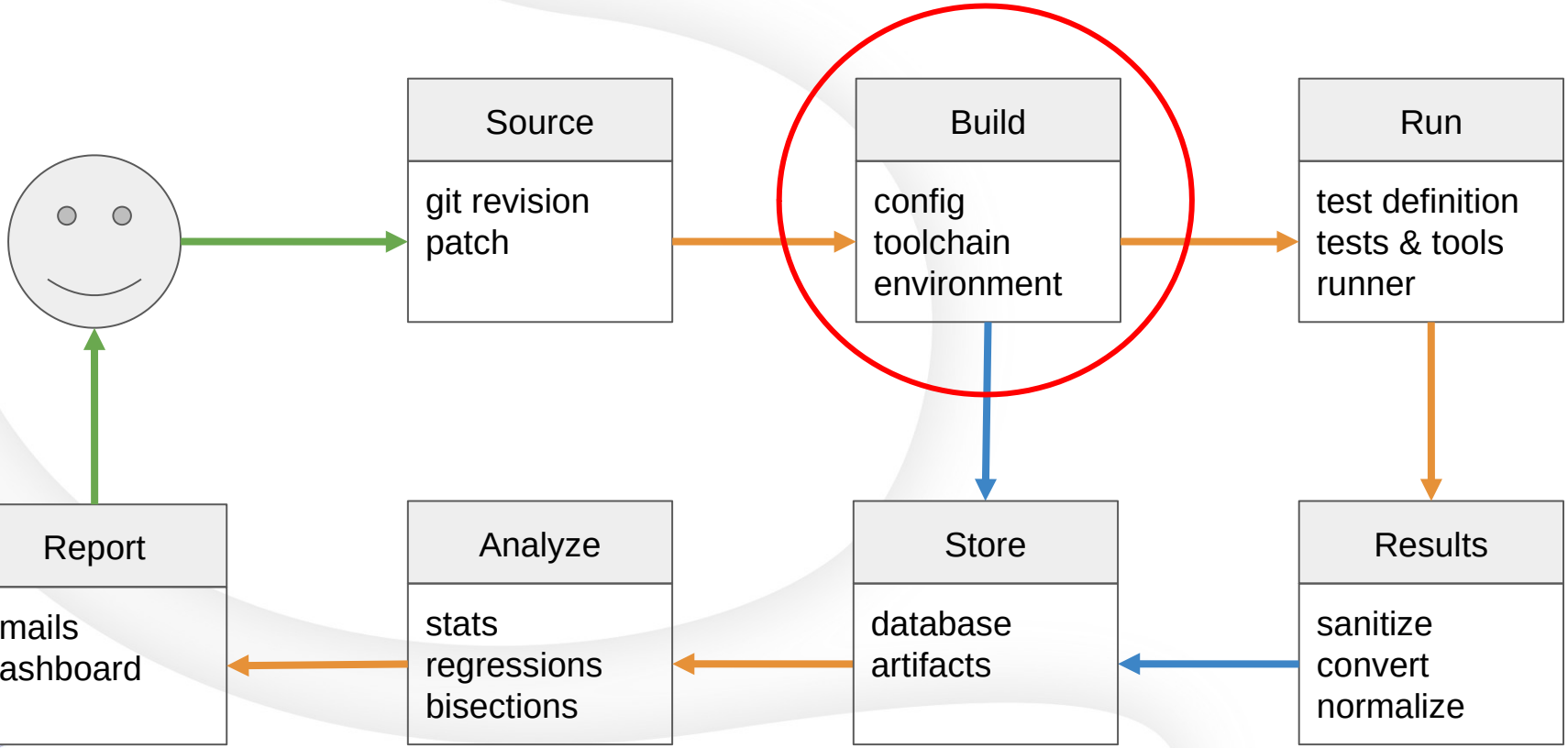
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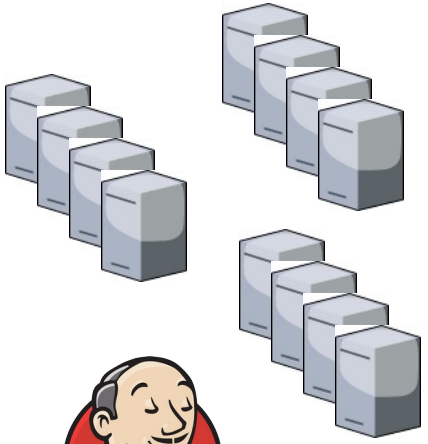
Kernel Builds

For each source tree

- multi-arch: arc, arm[64], x86, mips, ~~RISC-V~~
- multi-compiler: gcc, clang
- multi-defconfig: upstream defconfigs, `all*config`
- per-tree customization: `build-configs.yaml`
- modules, kselftests



Orchestration / devops

- CI/CD pipeline (Jenkins)
- Static VMs, cloud VMs
- Kubernetes

kubernetes

Google Cloud

Azure

Stats

- average > 2000 builds/day

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```
arch:                   "arm64"
build_environment:      "gcc-8"
build_log:              "build.log"
build_platform:
  0:                    "Linux"
  1:                    "88494f47bacb"
  2:                    "4.19.0-9-cloud-amd64"
  3:                    "#1 SMP Debian 4.19.118-2 (2020-04-29)"
  4:                    "x86_64"
  5:                    ""
build_threads:          10
build_time:             972.67
compiler:               "gcc"
compiler_version:       "8"
compiler_version_full:  "aarch64-linux-gnu-gcc (Debian 8.3.0-2) 8.3.0"
cross_compile:          "aarch64-linux-gnu-"
defconfig:              "defconfig"
defconfig_full:         "defconfig"
dtb_dir:                "dtbs"
file_server_resource:   "stable/linux-5.4.y/v5.4.45/arm64/defconfig/gcc-8"
git_branch:             "linux-5.4.y"
git_commit:             "3604bc07c035939266d78d65084c6cd54ffc6d56"
git_describe:           "v5.4.45"
git_describe_v:         "v5.4.45"
git_url:                "https://git.kernel.org/pub/scm/linux/kernel/git/stable/linux-stable.git"
job:                    "stable"
kconfig_fragments:      ""
kernel_config:          "kernel.config"
kernel_image:           "Image"
modules:                "modules.tar.xz"
status:                 "PASS"
system_map:             "System.map"
text_offset:            "0x10080000"
vmlinux_bss_size:       457640
vmlinux_data_size:      1825472
vmlinux_file_size:      322925656
vmlinux_text_size:      12261160
```


Raw data

- Kernel image(s): [bz]Image
- System.map
- DTBs
- modules
- kselftests
- build logs

Metadata

- Image size (text, data, bss)
- build time
- build error / warning counts
- ...

n/kernelci/kernelci-core/

Build - Next

Static builders/VMs → kubernetes

Devops

Re-usable tooling

Python3 migration

Modern (k8s) CI/CD pipeline

- Tekton?
- Concourse?

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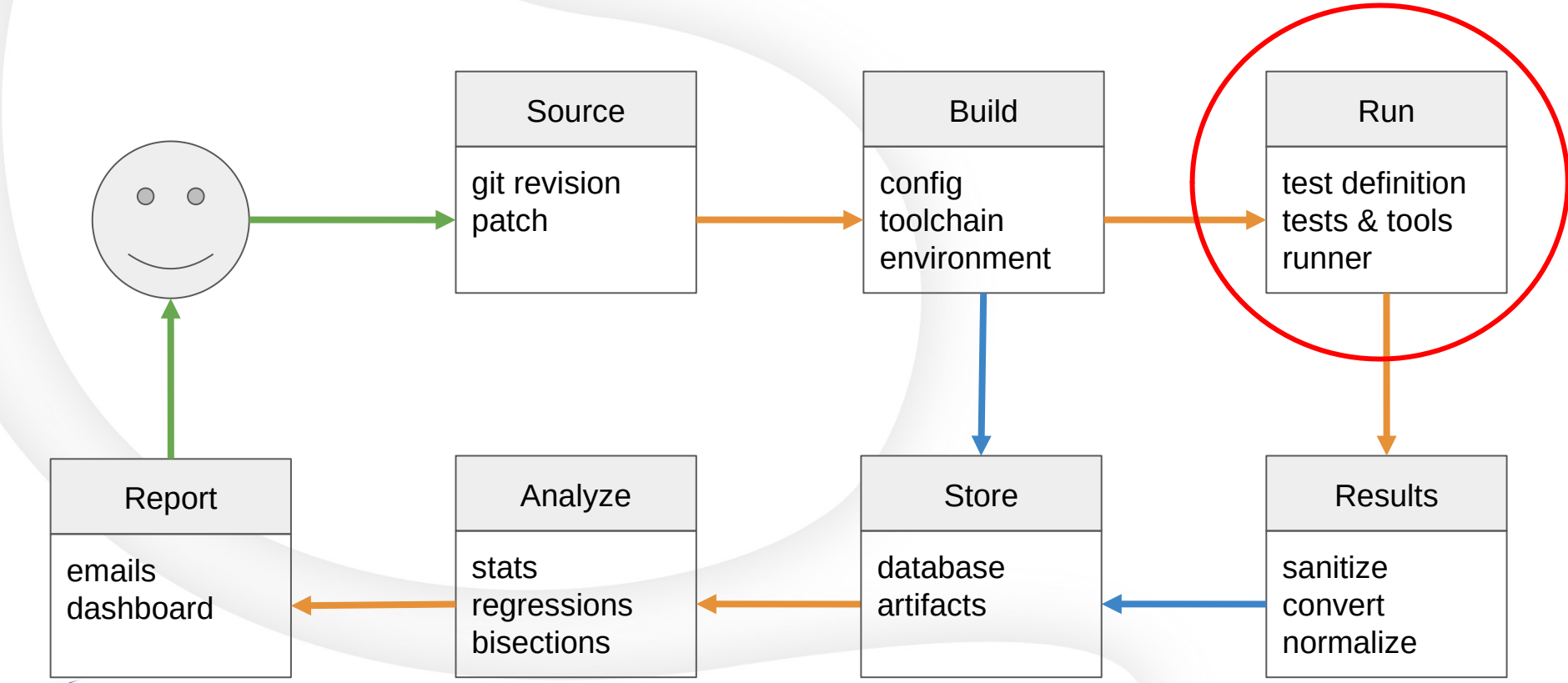
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Running tests: Lab

- Physical Labs
  - ~10 distributed lab
- Test Platforms
  - scheduling
  - resource allocation
  - dependency checking
- Architecture
  - arc
  - arm
  - arm64
  - i386
  - x86_64
  - mips
  - RISC-V

LAVA

Beaker

- Boot types
  - u-boot
  - fastboot
  - GRUB
  - UEFI
  - coreboot + depthcharge
- DUT/Boards/VM
  - arc: hsdk
  - arm: da850-lcdk
  - arm64: meson-g12b-odroid-n2
  - i386: QEMU
  - x86_64
  - mips: omega2p
  - riscv: hifive-unleashed-a00

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Run: Tools & Tests

- Build artifacts
  - Build images
  - dtbs.json
  - bmeta.json
- kci_test tool
  - Generate
    - Test Plan
    - Lab
    - Storage
    - User
    - Token
  - Submit
    - Lab
    - user
    - token
    - Job definition

storage.kernelci.org/stable/linux-5.6.y/v5.6.15/riscv/defconfig/gcc-8/dtbs.json


```
{
    "dtbs": [
        "sifive/hifive-unleashed-a00.dtb"
    ]
}
```


storage.kernelci.org/stable/linux-5.6.y/v5.6.15/riscv/defconfig/gcc-8/bmeta.json


```
{
    "arch": "riscv",
    "build_environment": "gcc-8",
    "build_log": "build.log",
    "build_platform": [
        "Linux",
        "9dce4443be1c",
        "4.4.0-174-generic",
        "#204-Ubuntu SMP Wed Jan 29 06:41:01 UTC 2020",
        "x86_64",
        ""
    ],
    "build_threads": "4",
    "build_time": 310.51,
    "compiler": "gcc",
    "compiler_version": "8",
    "compiler_version_full": "riscv64-linux-gnu-gcc (Debian 8.3.0-2) 8.3.0",
    "cross_compile": "riscv64-linux-gnu-",
    "defconfig": "defconfig",
    "defconfig_full": "defconfig",
    "dtb_dir": "dtbs",
    "file_server_resource": "stable/linux-5.6.y/v5.6.15/riscv/defconfig/gcc-8",
    "git_branch": "linux-5.6.y",
    "git_commit": "183673bef8533a3744ad27e32ca901de59e09307",
    "git_describe": "v5.6.15",
    "git_describe_v": "v5.6.15",
    "git_url": "https://git.kernel.org/pub/scm/linux/kernel/git/stable/linux-stable.git",
    "job": "stable",
    "kconfig_fragments": "",
    "kernel_config": "kernel.config",
    "kernel_image": "Image",
    "modules": "modules.tar.xz",
    "status": "PASS",
    "system_map": "System.map",
    "text_offset": "0x0003ac68",
    "vmlinux_bss_size": 318912,
    "vmlinux_data_size": 382304,
    "vmlinux_file_size": 12804616,
    "vmlinux_text_size": 6513594
}
```


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KernelCI

https://github.com/kernelci/kernelci-core/blo

Results: LAVA example

Other test suites

- Power: suspend / resume
- Media: v4l2-compliance
- Graphics: IGT
- USB: smoke test

```
# Job: next-master-next-20200511-arm64-defconfig-gcc-8-meson-g12a-sei510.dtb-meson-g12a-sei510-sleep
context:
  extra_kernel_args: console_msg_format=syslog

job_name: next-master-next-20200511-arm64-defconfig-gcc-8-meson-g12a-sei510.dtb-meson-g12a-sei510-sleep
timeouts:
  job:
    - test:
        timeout:
          minutes: 5
        definitions:
        - repository:
            metadata:
              format: Lava-Test Test Definition 1.0
              name: sleep
              description: "sleep test plan"
              os:
              - oe
              scope:
              - functional
            run:
              steps:
                - >
                  if (mem in "mem") or ( not "mem" )
                    for i in $(seq 1 10); do
                      lava-test-case rtcwake-mem-$i --shell \
                        rtcwake -d rtc0 -m mem -s 5
                    done
                  endif
                - >
                  if (freez in "mem") or ( not "mem" )
                    for i in $(seq 1 10); do
                      lava-test-case rtcwake-freeze-$i --shell \
                        rtcwake -d rtc0 -m freeze -s 5
                    done
                  endif
        lava-signal: kmsg
        from: inline
        name: sleep
        path: inline/sleep.yaml
```

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KernelCI

Run - Next

More test plans

- kselftest, KUnit (in progress)
- LTP
- syzbot / syzcaller reproducers
- xfstests
- `$YOUR_FAVORITE_TEST_SUITE`
- ...

Distro testing?

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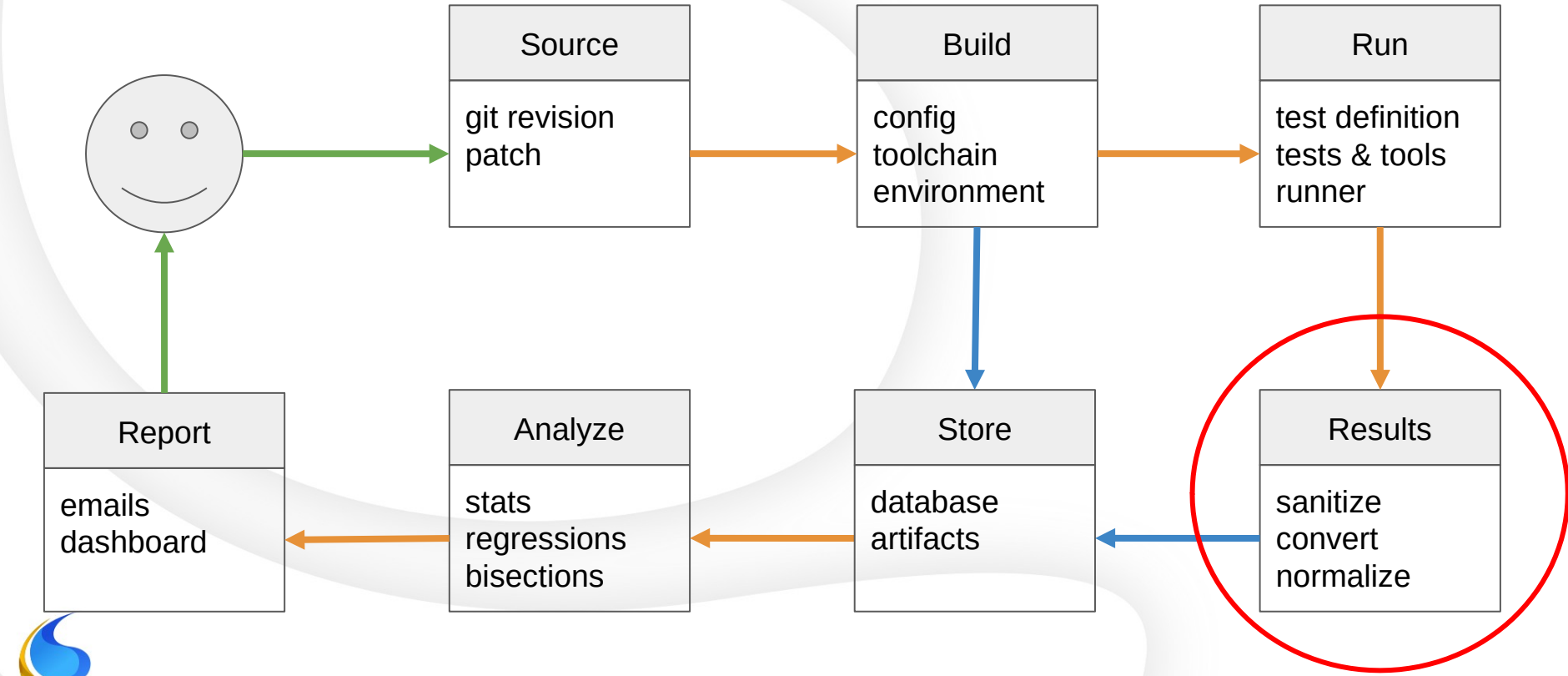
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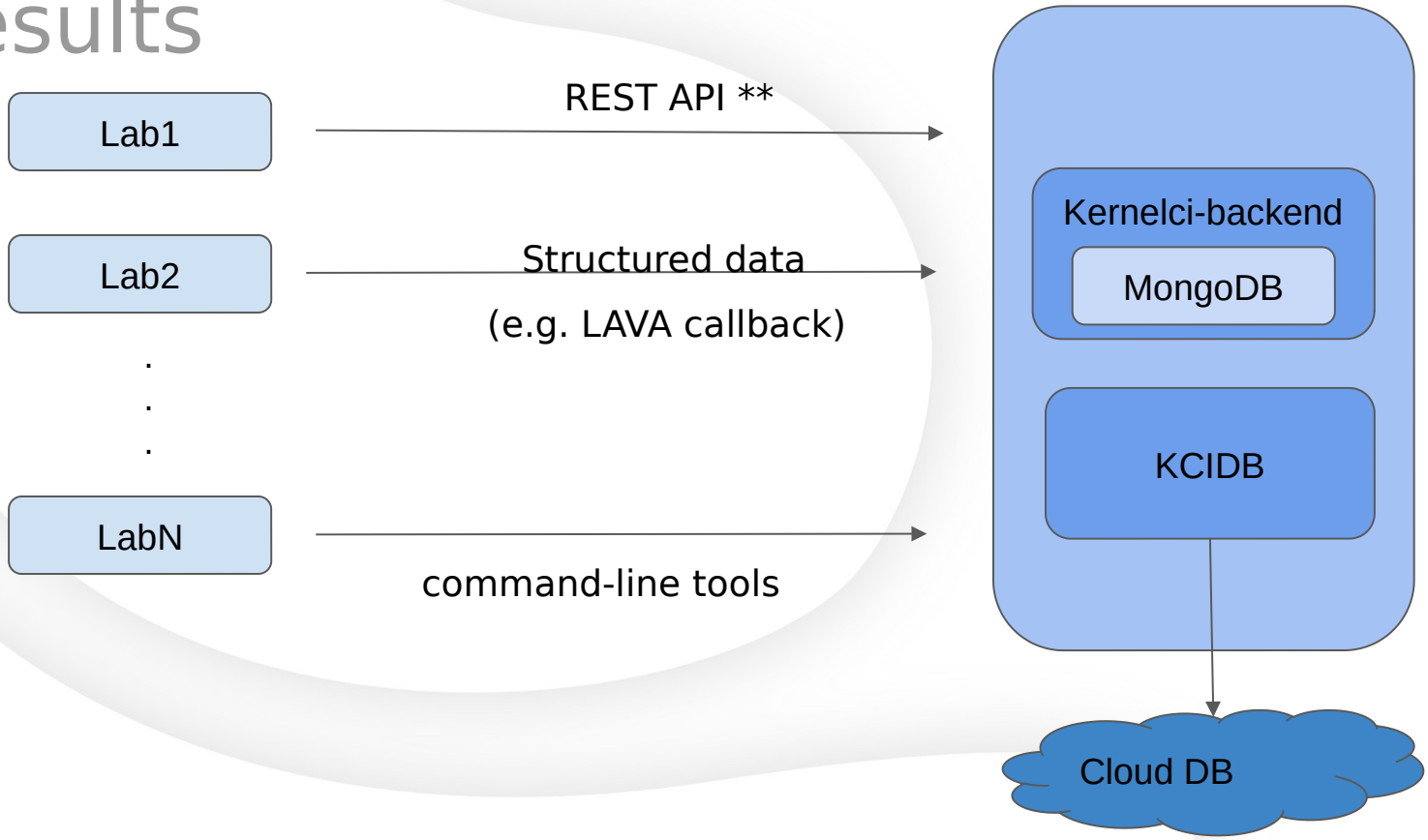
Results



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KernelCI

** https://api.kernelci.org/

Results example: LAVA

LAVA json file for meson-sm1-khadas-vim3

- actual_device_id
- Lab_name
- Results
- logs

JSON Raw Data Headers

Save Copy Collapse All Expand All (slow) Filter JSON


```
status:              2
boot_log_html:       "baseline-meson-sm1-khadas-vim3l.html"
actual_device_id:    "meson-sm1-khadas-vim3l-02"
version:             "1.1"
status_string:       "complete"
submitter_username:  "kernel-ci"
submit_time:         "2020-06-09 16:32:41.380247+00:00"
id:                  109492
▸ results:           {…}
priority:            50
```



```
▾ results:
  ▾ 0_dmesg:
"- id: '1717307'\n  job: '109492'\n  level: ''\n  log_end_line: '1021'\n  log_start_line: '1021'\n  logged: '2020-06-09
16:39:22.987287+00:00'\n  measurement: 0E-10\n  metadata: {case: emerg, definition: 0_dmesg, measurement: '0', result:
pass, units: lines}\n  name: emerg\n  result: pass\n  suite: 0_dmesg\n  unit: lines\n  url: /results/testcase/1717307\n-
id: '1717306'\n  job: '109492'\n  level: ''\n  log_end_line: '1017'\n  log_start_line: '1017'\n  logged: '2020-06-09
16:39:22.987255+00:00'\n  measurement: 0E-10\n  metadata: {case: alert, definition: 0_dmesg, measurement: '0', result:
pass, units: lines}\n  name: alert\n  result: pass\r  suite: 0_dmesg\n  unit: lines\n  url: /results/testcase/1717306\n-
id: '1717305'\n  job: '109492'\n  level: ''\n  log_end_line: '1015'\n  log_start_line: '1015'\n  logged: '2020-06-09
16:39:22.987223+00:00'\n  measurement: 0E-10\n  metadata: {case: crit, definition: 0_dmesg, measurement: '0', result:
pass, units: lines}\n  name: crit\n  result: pass\n  suite: 0_dmesg\n  unit: lines\n  url: /results/testcase/1717305\n"
```


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KernelCI

https://storage.kernelci.org/gtucker/kernelci-stable/v5.1.21/arm64/defconfig/gcc-8/lab-baylibre/lava-json-meson-g12a-u200.json

Results - What's Next

Data

- sanity checking on incoming data
  - required fields, etc.
- scaling for more data

Tools

- generalized cmdline tools to submit results from anywhere: `kci_data`

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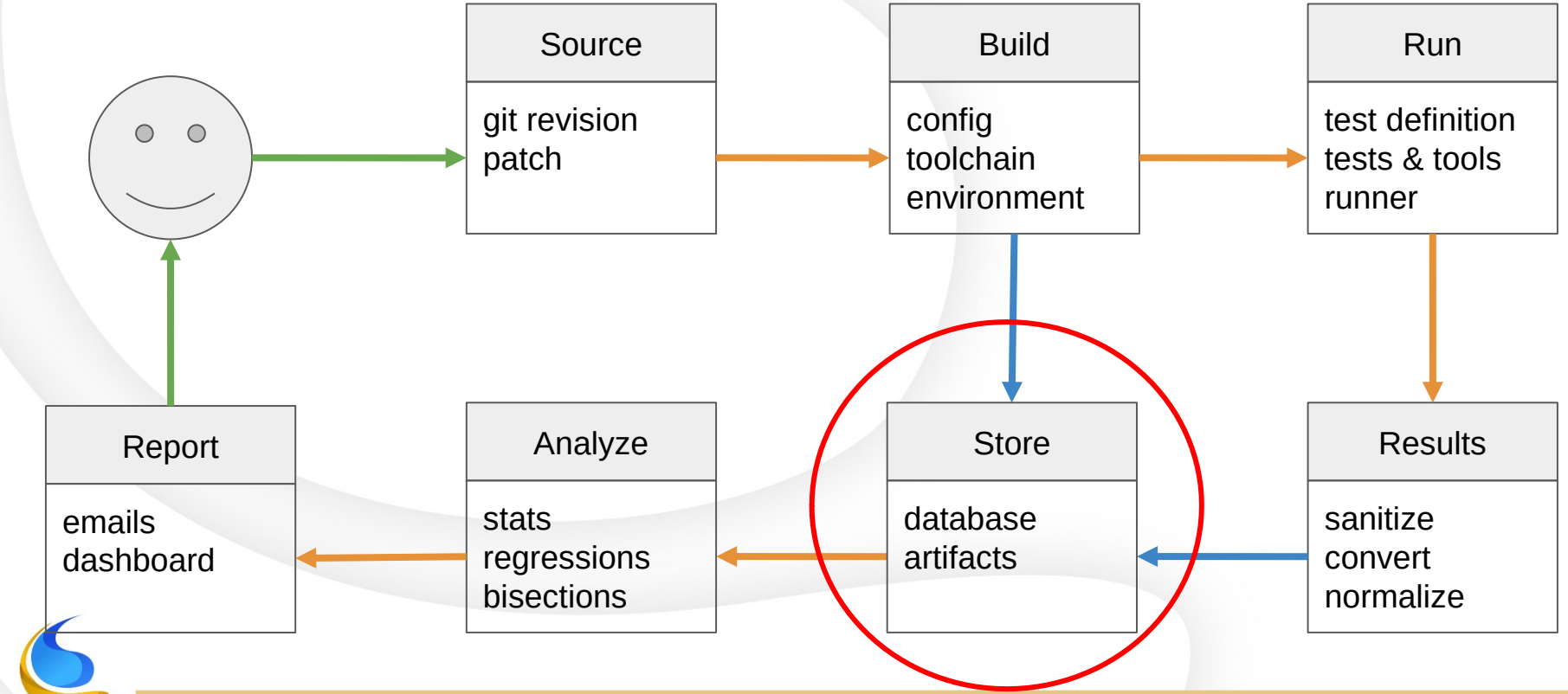
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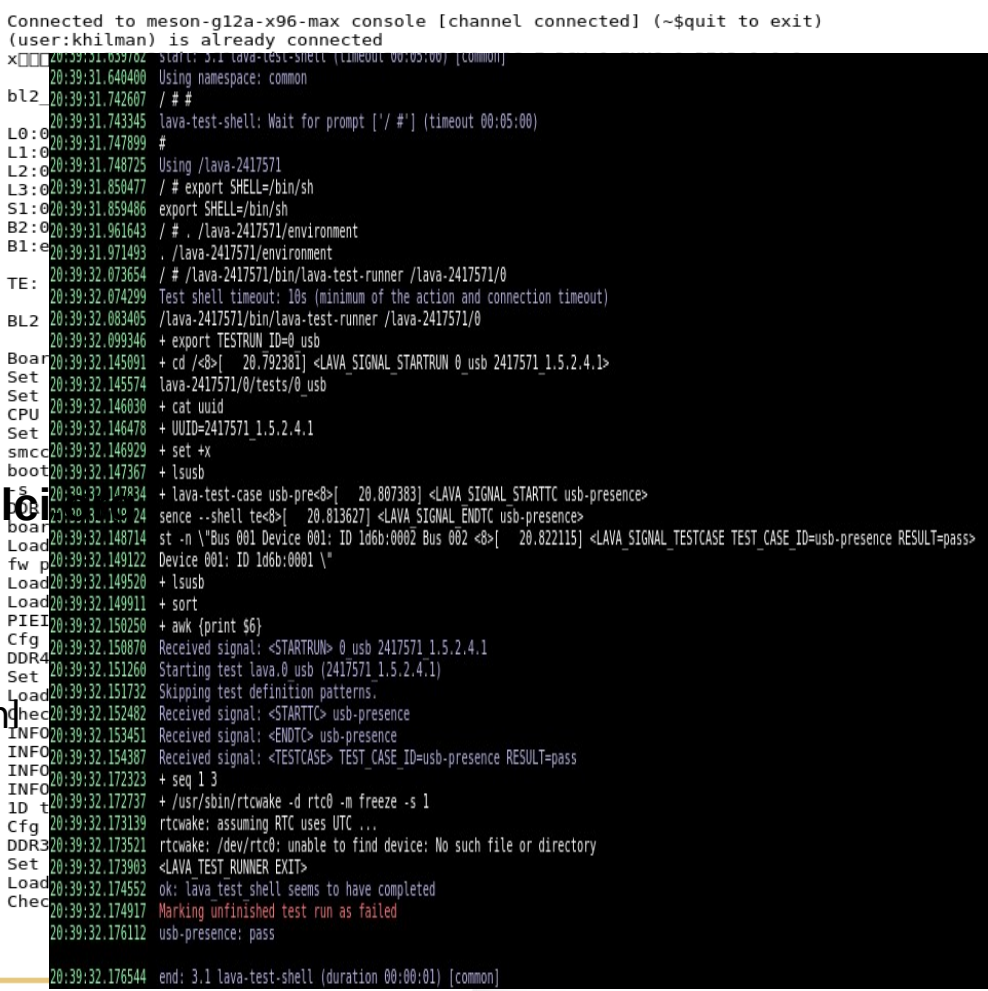
Store data

- Build artifacts
  - Build logs
  - Kernel, Ramdisk, Rootfs
  - Test images
  - DTBs - `dtbs.json`
  - metadata - `bmeta.json`

https://storage.kernelci

- Run artifacts
  - Test results : MongoDB
  - Boot logs
    - boot-meson-g12a-x96-max.html
    - boot-meson-g12a-x96-max.txt
  - Test logs
    - Usb-r8a7796-m3ulcb.html
    - Usb-r8a7796-m3ulcb.txt



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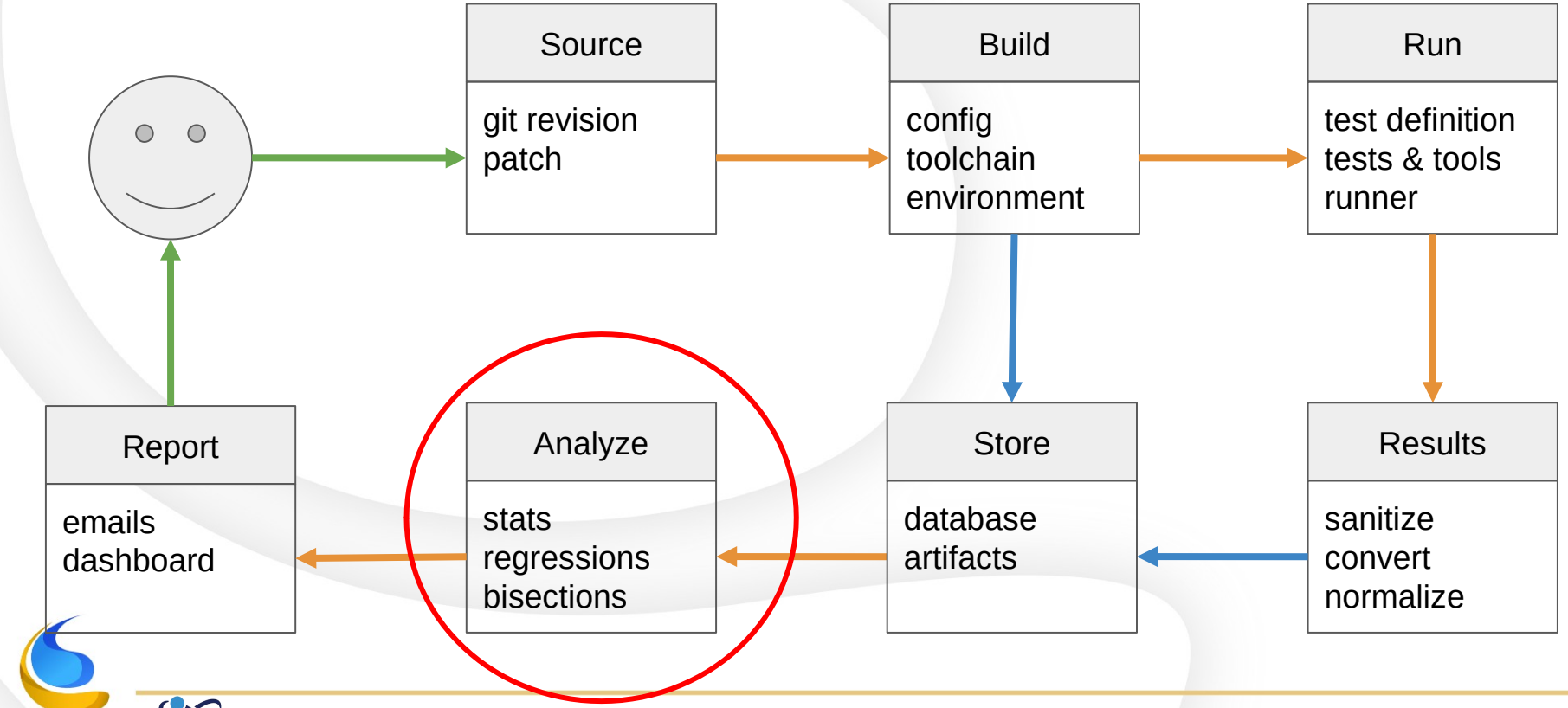
KernelCI

Store - What’s Next

Scaling

- LOTS more data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Analyze

Result data

Kernel-ci Backend

- Kernelci-backend: Analyze the data of
  - Build results
    - Pass
    - fail
  - Test results
    - Test Pass
    - Test Skip
    - Test Fail → New failure?

New failure? → Track regression

Track regression → Bisection

Bisection → Bad Patch → Report

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Analyze - What’s Next

Deeper analytics

AI / ML ?

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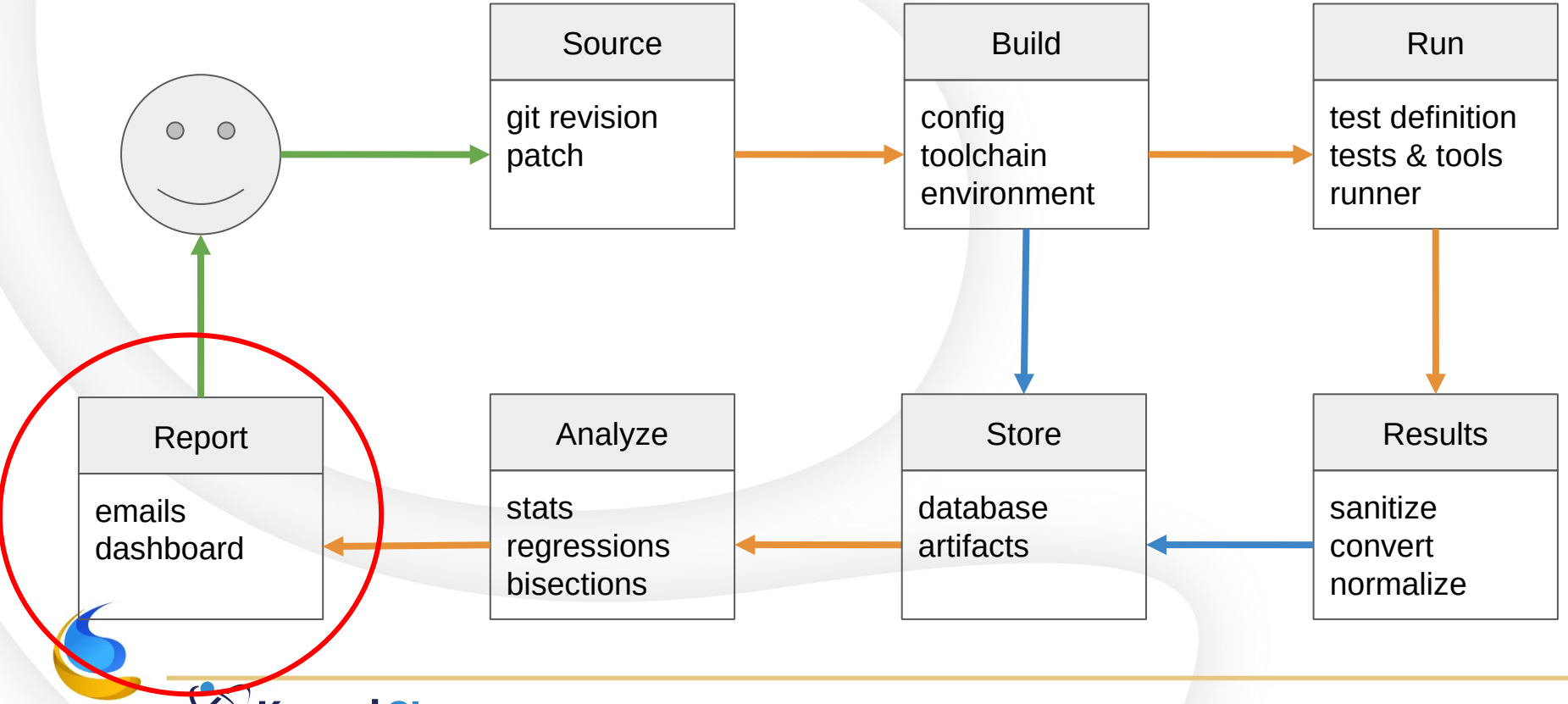
KernelCI



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KernelCI

Reportin

Email

Build report

Test reports

Bisection reports

```
kernelci.org bot <bot@kernelci.org> (Yest. 18:11) (lists/kernel-build-reports)
Subject: mainline/master baseline: 91 runs, 3 regressions (v5.8-rc1)
To: kernel-build-reports@lists.linaro.org, kernelci-results@groups.io
Date: Sun, 14 Jun 2020 18:11:12 -0700

mainline/master baseline: 91 runs, 3 regressions (v5.8-rc1)

Regressions Summary
-------------------

platform                  | arch  | lab          | compiler | defconfig                  | results
--------------------------+-------+--------------+----------+----------------------------+--------
at91-sama5d4_xplained     | arm   | lab-baylibre | gcc-8    | sama5_defconfig            | 0/1
bcm2837-rpi-3-b           | arm64 | lab-baylibre | gcc-8    | defconfig+CON...OMIZE_BASE=y | 4/5
meson-gxl-s805x-libretech-ac | arm64 | lab-baylibre | gcc-8 | defconfig+CON...OMIZE_BASE=y | 4/5

  Details:  https://kernelci.org/test/job/mainline/branch/master/kernel/v5.8-rc1/plan/baseline/

  Test:     baseline
  Tree:     mainline
  Branch:   master
  Describe: v5.8-rc1
  URL:      https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git
  SHA:      b3a9e3b9622ae10064826dccb4f7a52bd88c7407

Test Regressions
----------------

platform                  | arch  | lab          | compiler | defconfig                  | results
--------------------------+-------+--------------+----------+----------------------------+--------
at91-sama5d4_xplained     | arm   | lab-baylibre | gcc-8    | sama5_defconfig            | 0/1

  Details:     https://kernelci.org/test/plan/id/5ee69344e8435c781397bf09

  Results:     0 PASS, 1 FAIL, 0 SKIP
  Full config: sama5_defconfig
  Compiler:    gcc-8 (arm-linux-gnueabihf-gcc (Debian 8.3.0-2) 8.3.0)
  Plain log:   https://storage.kernelci.org//mainline/master/v5.8-rc1/arm/sama5_defconfig/gcc-8/lab-baylibre/baseline-at91-sama5d4_xplained.txt
  HTML log:    https://storage.kernelci.org//mainline/master/v5.8-rc1/arm/sama5_defconfig/gcc-8/lab-baylibre/baseline-at91-sama5d4_xplained.html
  Rootfs:      http://storage.kernelci.org/images/rootfs/buildroot/kci-2019.02-11-g17e793fa4728/armel/baseline/rootfs.cpio.gz

  * baseline.login: https://kernelci.org/test/case/id/5ee69344e8435c781397bf0a
      failing since 75 days (last pass: v5.6-2112-g673b41e04a03, first fail: v5.6-2330-g458ef2a25e0c)
```

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KernelCI

Exampl

Bisection email

kernelci.org bot <bot@kernelci.org> (May 01) (inbox lists/to-me)
Subject: stable-rc/linux-5.4.y bisection: baseline.dmesg.alert on meson-g12a-x96-max
To: broonie@kernel.org, khilman@baylibre.com, mgalka@collabora.com, tomeu.vizoso@collabora.com, enric.balletbo@collabora.com, guillaume.tuck
Date: Fri, 01 M

* * * * * * * * * *
* This automat
* that you may
* found. No ma
* and the root
*
* If you do sen
* Reported-by
*
* Hope this hel
* * * * * * * * * *

stable-rc/linux-

Summary:
Start: 35bb
Plain log:
https://storage
HTML log:
https://storage
Result: 09f4

Checks:
revert: PASS
verify: PASS

Parameters:
Tree: stab
URL: http
Branch: linux
Target: mes
CPU arch:
Lab: lab-
Compiler:
Config: defc
Test case:

Breaking commit found:

---

commit 09f4294793bd3e70d68fdab5b392dff18bff62ca
Author: <...>
Date: Mon Apr 20 13:45:10 2020 +0200

ASoC: meson: axg-card: fix codec-to-codec link setup

[...]

Git bisection log:

---

git bisect start
good: [aa73bcc376865c23e61dcebd467697b527901be8] Linux 5.4.36
git bisect good aa73bcc376865c23e61dcebd467697b527901be8
bad: [35bbc55d9e296d37cf01555d415338b84a70d4c5] Linux 5.4.37-rc1
git bisect bad 35bbc55d9e296d37cf01555d415338b84a70d4c5
bad: [924f1d37852ff357658c205dd114c70862865fc9] svcrdma: Fix trace point use-after-free race
git bisect bad 924f1d37852ff357658c205dd114c70862865fc9
good: [b848f65436665b5fe675fd3f645c1a458e49f60a] counter: 104-quad-8: Add lock guards - generic interface
git bisect good b848f65436665b5fe675fd3f645c1a458e49f60a
bad: [04b53ed855129c1703d00d8494e4c61309714a99] drivers: soc: xilinx: fix firmware driver Kconfig dependency
git bisect bad 04b53ed855129c1703d00d8494e4c61309714a99
good: [ae886eae0318c71a6125347d6810a1578a83d262] ASoC: tas571x: disable regulators on failed probe
git bisect good ae886eae0318c71a6125347d6810a1578a83d262
bad: [2c0990070379284dda0b51304ce19c2b96e083a2] ASoC: wm8960: Fix wrong clock after suspend & resume
git bisect bad 2c0990070379284dda0b51304ce19c2b96e083a2
bad: [09f4294793bd3e70d68fdab5b392dff18bff62ca] ASoC: meson: axg-card: fix codec-to-codec link setup
git bisect bad 09f4294793bd3e70d68fdab5b392dff18bff62ca
first bad commit: [09f4294793bd3e70d68fdab5b392dff18bff62ca] ASoC: meson: axg-card: fix codec-to-codec link setup
---

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Reporting - Web dashboards - kern

Available Jobs

The results shown here cover the last **14 days** of available data starting from **Mon, 15 Jun 2020** (time is UTC based).

25 **jobs per page**

Filter the results

Tree	Branch	Latest Build Status	Latest Test Results	Date	Status
android	android-3.18	112 112 0 0	182 126 0 56	2020-06-15	✓
android	android-5.4-stable	97 97 0 0	528 440 7 81	2020-06-15	✓
pmwg	integ	165 162 3 0	354 338 6 10	2020-06-15	✓
krzysztof	for-next	154 149 5 0	469 449 4 16	2020-06-15	✓
lee	android-3.18-preview	114 114 0 0	107 75 0 32	2020-06-15	✓
media	master	92 89 3 0	912 887 5 20	2020-06-15	✓
next	master	168 165 3 0	1,918 1,439 10 469	2020-06-15	✓
next	pending-fixes	155 151 4 0	734 709 5 20	2020-06-14	✓
mainline	master	146 142 4 0	422 407 3 12	2020-06-14	✓
net-next	master	153 149 4 0	608 583 6 19	2020-06-14	✓
rt-stable	v4.9-rt	168 166 2 0	181 136 1 44	2020-06-13	✓
rt-stable	v4.14-rt	169 169 0 0	267 184 19 64	2020-06-13	✓
android	android-4.19-stable	105 105 0 0	497 382 7 108	2020-06-13	✓
android	android-mainline	94 94 0 0	592 528 17 47	2020-06-12	✓

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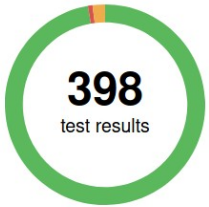
Reporting - Web dashboard - kernelci.org

Regressions

Details for baseline: «mainline» - v5.8-rc1 (master)

Tree	mainline —
Git branch	master
Git describe	v5.8-rc1 —
Git URL	https://git.kernel.org/pub/scm /linux/kernel/git/torvalds /linux.git
Git commit	b3a9e3b9622ae10064826dccb4f7a52bd88c7407
Date	2020-06-14



Test Runs

All | Successful | Regressions | Unknown

Filter the results

Lab «lab-baylibre» (338 — 328 / 3 / 7)

- at91-sama5d4_xplained sama5_defconfig - arm - gcc-8
- bcm2837-rpi-3-b defconfig+CONFIG_RANDOMIZE_BASE=y - arm64 - gcc-8
- meson-gxl-s805x-libretech-ac defconfig+CONFIG_RANDOMIZE_BASE=y - arm64 - gcc-8

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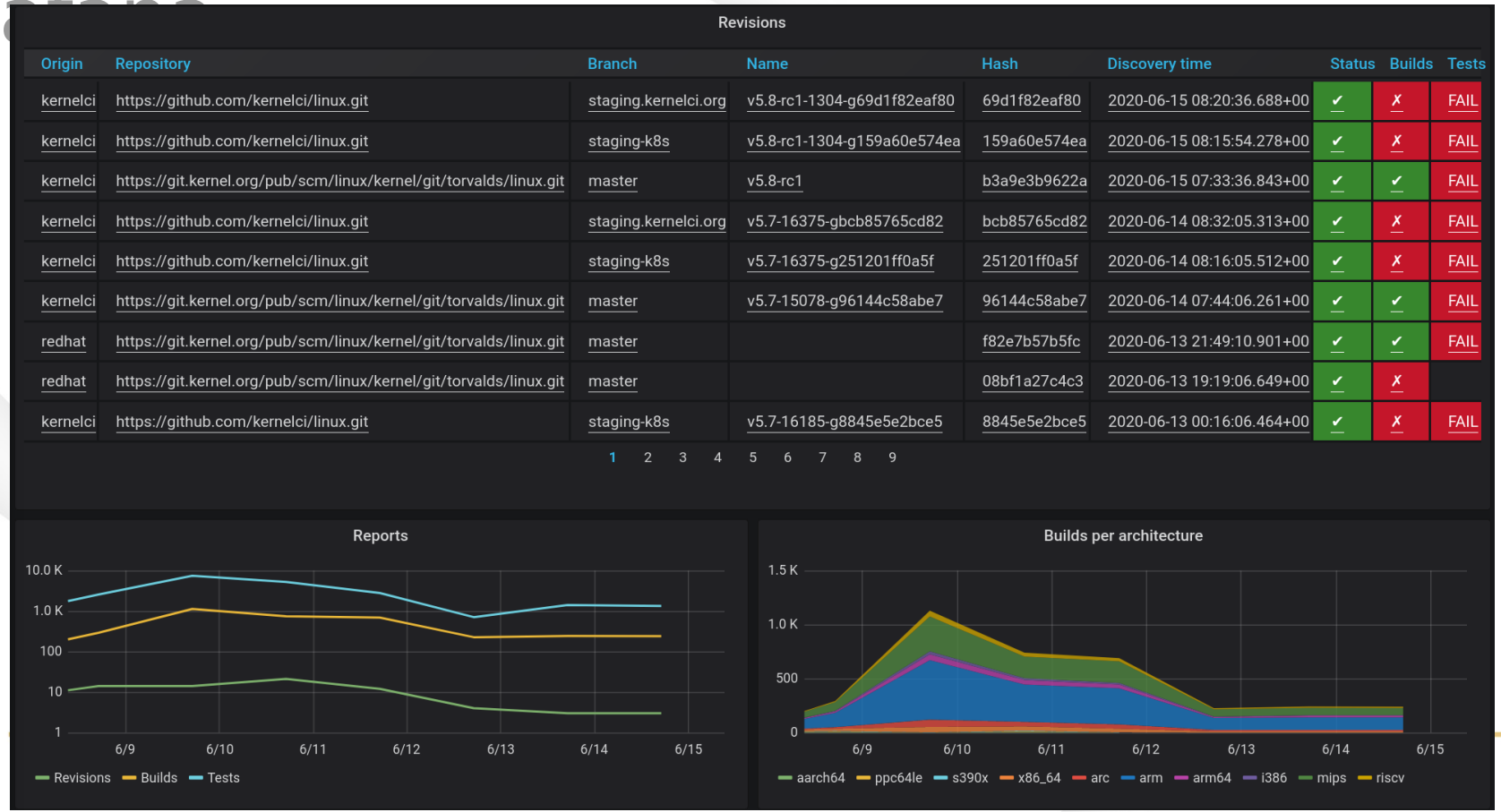
Reports - Web dashboards - kcidb Grafana



Revisions

Origin	Repository	Branch	Name	Hash	Discovery time	Status	Builds	Tests
kernelci	https://github.com/kernelci/linux.git	staging.kernelci.org	v5.8-rc1-1304-g69d1f82eaf80	69d1f82eaf80	2020-06-15 08:20:36.688+00	✓	✗	FAIL
kernelci	https://github.com/kernelci/linux.git	staging-k8s	v5.8-rc1-1304-g159a60e574ea	159a60e574ea	2020-06-15 08:15:54.278+00	✓	✗	FAIL
kernelci	https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git	master	v5.8-rc1	b3a9e3b9622a	2020-06-15 07:33:36.843+00	✓	✓	FAIL
kernelci	https://github.com/kernelci/linux.git	staging.kernelci.org	v5.7-16375-gbcb85765cd82	bcb85765cd82	2020-06-14 08:32:05.313+00	✓	✗	FAIL
kernelci	https://github.com/kernelci/linux.git	staging-k8s	v5.7-16375-g251201ff0a5f	251201ff0a5f	2020-06-14 08:16:05.512+00	✓	✗	FAIL
kernelci	https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git	master	v5.7-15078-g96144c58abe7	96144c58abe7	2020-06-14 07:44:06.261+00	✓	✓	FAIL
redhat	https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git	master		f82e7b57b5fc	2020-06-13 21:49:10.901+00	✓	✓	FAIL
redhat	https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git	master		08bf1a27c4c3	2020-06-13 19:19:06.649+00	✓	✗	
kernelci	https://github.com/kernelci/linux.git	staging-k8s	v5.7-16185-g8845e5e2bce5	8845e5e2bce5	2020-06-13 00:16:06.464+00	✓	✗	FAIL

1 2 3 4 5 6 7 8 9

Reports

10.0 K
1.0 K
100
10
1
6/9 6/10 6/11 6/12 6/13 6/14 6/15
Revisions Builds Tests

Builds per architecture

1.5 K
1.0 K
500
0
6/9 6/10 6/11 6/12 6/13 6/14 6/15
aarch64 ppc64le s390x x86_64 arc arm arm64 i386 mips riscv

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Reporting - What’s next

Modernize UI / UX

All reporting uses same db: kcidb

Customizable email reports

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KernelCI

Recap

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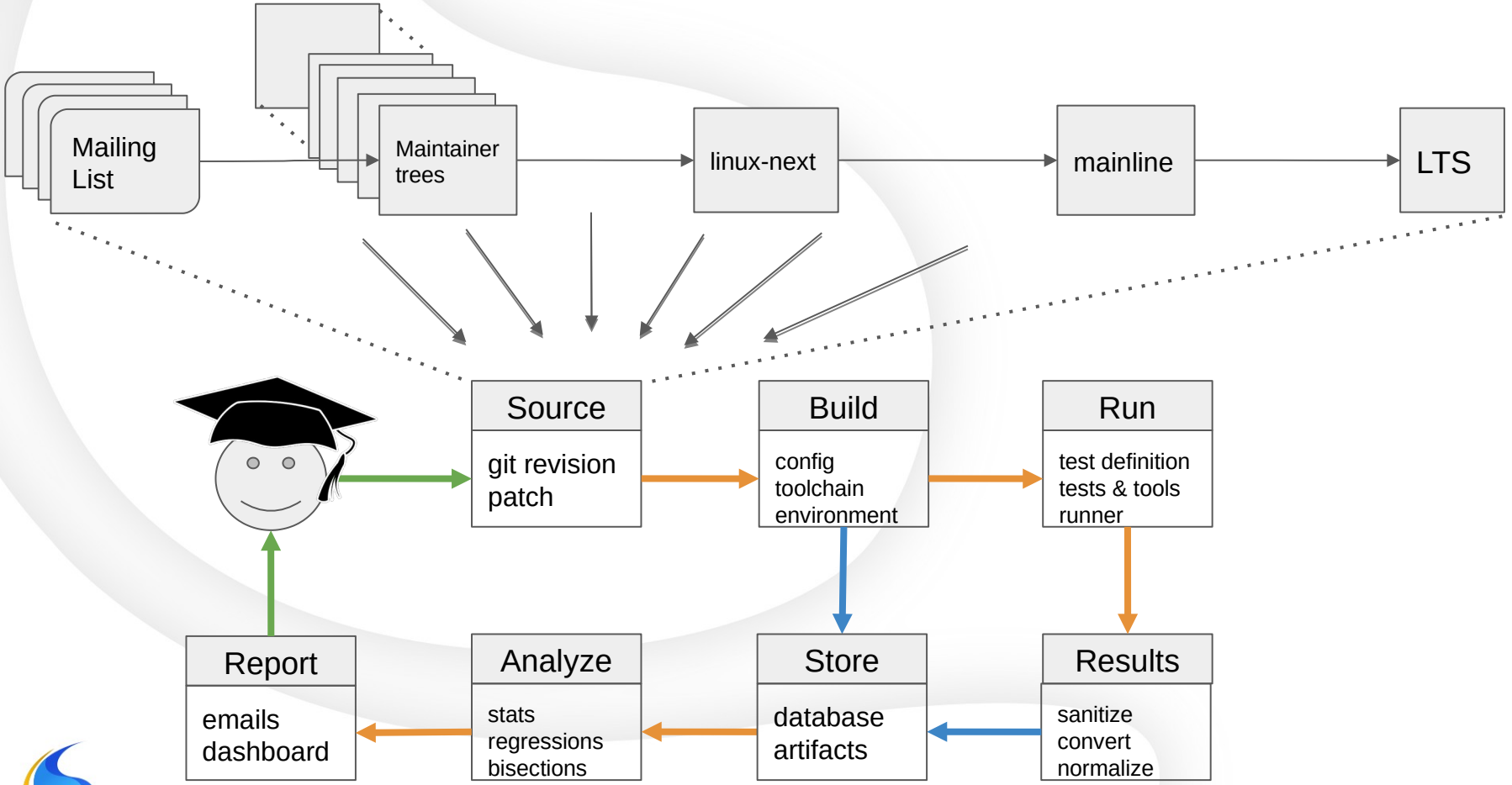
KernelCI


Mailing List
Maintainer trees
linux-next
mainline
LTS
Source
git revision
patch
Build
config
toolchain
environment
Run
test definition
tests & tools
runner
Report
emails
dashboard
Analyze
stats
regressions
bisections
Store
database
artifacts
Results
sanitize
convert
normalize

Getting Involved

Blog: https://foundation.kernelci.org/blog/

Twitter: https://twitter.com/kernelci (#kernelci, @KernelCI)

Mailing list: https://groups.io/g/kernelci/topics

IRC: #kernelci on Freenode

Weekly technical call: Tuesdays: 16h-17h UTC

LinkedIn: https://www.linkedin.com/company/kernelci-org/

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Lab icon: https://www.stockio.com/free-icon/antonella-science-lab-flask
Tools icon: ”Icon made by Freepik from www.flaticon.com"
Analyze icon: ”Icon made by Geotatah from www.flaticon.com"